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UNITED STATES DISTRICT COURT
NORTHERN DISTRICT OF CALIFORNIA

In re DYNAMIC RANDOM ACCESS
MEMORY (DRAM) ANTITRUST
LITIGATION

Case No. M-02-1486-PJH

MDL No. 1486

This Document Relates To:

ALL DIRECT PURCHASER
ACTIONS

**DECLARATION OF VINCENT E.
O'BRIEN IN SUPPORT OF MOTION
TO EXCLUDE TESTIMONY OF
PAUL C. LIU**

Date: March 22, 2007
Time: 9:00 a.m.
Ctmm.: 3
Judge: Hon. Phyllis J. Hamilton

1 I, Vincent E. O'Brien, declare:

2 1. I am the president of Marin Economic Research Institute. I am also a
3 Director of LECG, LLC (formerly the Law and Economics Consulting Group), a worldwide
4 economic consulting firm specializing in applying economic analysis to complex legal issues. I
5 hold a Bachelor of Science in Electrical Engineering with High Honors from the University of
6 Illinois (1967) and a Masters (1969) and Doctorate (1973) in Business Administration from the
7 Harvard Graduate School of Business Administration. I have been engaged by defendants
8 Nanya Technology Corporation ("NTC") and Nanya Technology Corporation USA ("NTC
9 USA") as an expert witness on causation and damages issues in this case. A copy of my resume
10 is attached to this declaration as Exhibit A.

11 2. I have been engaged in economic and financial analysis and forecasting
12 for over forty years. I have testified as an expert economic and financial analyst for plaintiffs
13 and for defendants at deposition or trial over 179 times in matters involving patent, antitrust,
14 intellectual property, securities and other types of complex business claims. I have been
15 admitted as an expert witness by over fifty courts, and have testified sixty-four times at trial, as
16 well as ten times before various regulatory bodies and twice before committees of the U.S.
17 House and Senate. No court has ever refused to qualify me as an expert witness.

18 3. I have undertaken an analysis of the various econometric models presented
19 by Dr. Paul C. Liu in his original and rebuttal reports. I have also reviewed his deposition
20 testimony related to each report. I have submitted an expert report in response to Dr. Liu's
21 original report, and I anticipate testifying in response to both of Dr. Liu's reports in my
22 testimony at trial. If called as a witness, I would testify to the following.

23 **I. INTRODUCTION**

24 4. Dr. Liu has estimated the putative "price elevation" of the alleged
25 conspiracy by employing a model that utilizes as its central assumption an extreme form of
26 aggregation – estimating a common "price elevation" over firms, products and time. Dr. Liu's
27 methodology rests on the assumption that there is a single percentage price change common to
28

1 all transactions within the time period identified by Plaintiffs as the class period.¹ Dr. Liu was
2 not compelled by data limitations or other factors to make this assumption, as he had access to
3 data that were disaggregated across all three dimensions.²

4 5. Dr. Liu wrote in his rebuttal report that “there is no reason why the
5 effectiveness of the conspiracy could not have varied somewhat over time.”³ Of course this is
6 true. However, the econometrics underlying Dr. Liu’s pooled model requires the assumption that
7 the effectiveness was common for the results of that model to have any validity. So if Dr. Liu
8 believes that the conspiracy’s “price elevation” was not common over his class period⁴, then
9 estimating a pooled measure of that elevation is certainly not appropriate.

10 6. However, having chosen to use a model which mandates this very strong
11 assumption, the data that Dr. Liu utilized provide a ready means to test whether his hypothesis of
12 a common “elevation” holds up, using a standard, commonly applied, statistical technique.
13 Indeed, it is standard practice in the profession to test such assumptions and hypotheses
14 (commonly referred to as the ‘parameter stability’ assumption).⁵ If his pooled model fails these
15 tests, it cannot be deemed reliable either as a matter of economics or statistics.

16 7. In the work that follows, I apply the standard test for parameter stability to
17 the assumption of a constant price change over different product types and find that Dr. Liu’s
18 model does not pass this test. In other words, it is clear that prices for different products do not
19 show similar “price elevations” during the alleged class period – some prices increased, and
20 many decreased, according to Dr. Liu’s model. I find similar results with respect to different

21 ¹ Alternately, some of his models rely on the assumption that there is a common “price elevation” for the portions of
22 the class period outside the eight-month period from April to November 2001.

23 ² Indeed, I anticipate that Dr. Liu may argue that some of the pooling was “necessary” because of a purportedly
24 small sample size. This is simply not true. The data underlying his transaction models contains hundreds of
25 thousands of observations. As part of his pooling process, Dr. Liu has chosen to aggregate his data across all
26 manufacturers and by month, and yet he still has well over 4,000 observations. To the extent that Dr. Liu believes
27 the aggregated model is too sparsely populated to undergo standard econometric tests, the appropriate response is
28 not to ignore the results of those tests, but rather to estimate the model without performing the pre-aggregation.

³ Rebuttal Report of Paul C. Liu, p. 22.

⁴ For example, if he believes that the conspiracy’s effect followed some of the more parabolic forms illustrated on
page 36 of his rebuttal report.

⁵ See, for example, my expert report in this matter at page 34, where I state, with respect to Dr. Liu’s original model
“... while [Dr. Liu’s] model is no longer consistent with the class claims, it is useful for the purpose of testing that
class-wide allegation. By dummifying out various periods, Dr. Liu’s model allows those periods to reveal whether
customers are commonly affected or not.”

1 time periods, different manufacturers, and different class members. I also apply the standard test
2 for parameter stability to the parameters for predicting prices outside the class period and find
3 that Dr. Liu's model also fails this test. From these tests (and others discussed below), I
4 conclude that Dr. Liu's damage estimates are unreliable.

5 8. Dr. Liu's data covers a variety of DRAM product types sold at various
6 times by different manufacturers. There are 75 products in the DeDios datasets he uses and 137
7 products in the Transactions data he uses. Hence, various products comprise much of the data
8 replication within his samples (4,537 observations for the DeDios data and 4,823 observations
9 for the Transaction data). Although he has not acknowledged this in his reports or deposition
10 testimony, the econometrics underpinning Dr. Liu's analysis requires that these products' prices
11 were uniformly affected by an alleged collusion, else the pooling of their results in a common
12 coefficient is inappropriate as a matter of economics and statistics. It is standard econometric
13 practice to test this assumption before relying on the results of such a model because this
14 assumption is critical to the validity of the conclusions that Dr. Liu draws.

15 9. The econometric methodology employed by Dr. Liu also has a second
16 important limitation: unless appropriate tests are applied, this methodology cannot provide direct
17 evidence that an alleged conspiracy actually *caused* prices to be abnormally high. The
18 econometric method is simply an interpretation of correlations. Correlations measure only how
19 closely variables move together. Correlation may or may not be due to an immediate causal link.
20 If changes in one variable actually cause changes in another, then generally the two variables
21 will be correlated. However, two variables will also be correlated when changes in both are
22 caused by a third variable such that there is no direct causal link between them. For this basic
23 reason, Dr. Liu's results do not provide direct evidence that an alleged conspiracy raised prices.
24 At best, his results could provide corroborating evidence of successful collusion,⁶ but only if the
25 model itself is deemed reliable. And similarly, his results, even if the model were deemed

26 ⁶ Dr. Liu acknowledged this in deposition that what his testimony on "impact" should mean is "the results of
27 econometric models can be consistent with a conspiracy." Deposition of Paul C. Liu, January 17, 2007, pp. 310:25 -
28 311:4. Given a valid model, I agree that regression results can demonstrate consistency (or inconsistency) with an
allegation. I do not understand how this could be seen as "evidence of impact" in any economic sense of those
words.

1 reliable (although it is not), it cannot rule out other potential (and lawful) causes for the change,
2 other than what has been accounted for by the included independent variables.

3 II. THE STANDARD TEST

4 10. In the terminology of statistics and econometrics, Dr. Liu is *pooling* data
5 sets to obtain his estimates. He has collected data for various product types and the data for each
6 product type is a dataset in its own right. Similarly, Dr. Liu has pooled together data from
7 different time periods and from different manufacturers and to different types of customers.
8 There is nothing wrong with the concept of pooling, and where appropriate, pooling across data
9 allows for more precise estimation of parameters. However, it is standard practice in statistics
10 and econometrics to test whether it is appropriate to pool data before relying upon the estimates
11 based on such pooling. The test examines parameter stability across the data sets to be pooled,
12 with the conclusion that if those parameters are not stable, the resulting model is unreliable. The
13 basic finding of this report is that Dr. Liu's models fail these basic pooling tests. As a result, the
14 "class period" variable is not reliable for measuring damages (or impact) in this case.

15 11. The standard econometric test is a generalization of a test that appears in
16 every introductory statistics book, the two-sample means test. That test checks whether two
17 datasets (or samples) are drawn from distributions with the same mean. If not, then the two
18 datasets should not be pooled to estimate a common mean. A common elementary statistics
19 homework assignment might involve testing whether it is appropriate to pool data on wages
20 across African-American and Latino employees, on the theory that if appropriate, a pooled mean
21 can be measured with more precision. However, if the standard two-sample means test rejects
22 the finding of a common mean, the pooling is found to be inappropriate and the "benefit" of
23 more data for estimating the mean is an illusory, misleading precision.

24 12. In econometrics, this test is generalized to testing whether linear
25 regression slopes⁷ are constant across datasets by measuring whether slopes estimated for each
26 dataset are close enough given their sampling variance. In their graduate level text book,
27 Davidson and MacKinnon describe the testing problem: "A classic problem in econometrics is

28 ⁷ Or intercepts, such as in the use of dummy variables.

1 determining whether the coefficients of a regression model (usually a linear one) are the same in
2 two (or sometimes more than two) separate subsamples.”⁸ Virtually all econometrics texts have
3 some treatment of the test procedure, often under the title “Chow test.”⁹ While a Chow test (and
4 its Wald, Likelihood Ratio, or Score test counterparts) is certainly more complex,
5 mathematically, at core it is merely a generalization, to the multiple regression context, of the
6 basic two-sample means test discussed in every basic statistics text.

7 **III. FIRST IMPLEMENTATION OF THE STANDARD TEST: PRODUCT POOLING**

8 13. The econometrics underpinning Dr. Liu’s method assumes that the alleged
9 conspiracy had a uniform price effect on all products for all customers and all manufacturers in
10 every month identified by the “class period” variable as a month of collusive pricing. Failure of
11 this assumption invalidates his estimates.¹⁰

12 14. Working with staff under my direction at LECG, I carried out the
13 appropriate statistical test under the other assumptions of Dr. Liu’s report and using the programs
14 Dr. Liu provided for his calculations. The results of this test appear in Appendix A. This test
15 clearly rejects the assumption. To communicate the character of the statistical evidence, I also
16 used Dr. Liu’s method to estimate the percentage price changes for each individual product.
17 Exhibit B graphs the values obtained for Dr. Liu’s Transaction data. They range by product from
18 negative 93% to positive 342%. Compared to Dr. Liu’s single estimate, these numbers vary
19 widely and include many negative values (some of which are found to be statistically
20 significantly lower than zero) that contradict the hypothesis of artificially elevated prices that
21 affected all products through the class period.

22 15. Repeating this test with the DeDios data leads to the same conclusion:

23 ⁸Russell Davidson and James G. MacKinnon, *Estimation and Inference in Econometrics*, Oxford Univ. Press:
24 Oxford, 1993, p. 375. I have included excerpts to all of my references to economics texts in Appendix B.

25 ⁹ For examples, see the following introductory econometrics textbooks: Arthur S. Goldberger, *A Course in*
26 *Econometrics*, Harvard Univ. Press: Cambridge, MA, 1991, p. 237; William H. Greene, *Econometric Analysis* (5th
27 ed.), Prentice Hall: Upper Saddle River, NJ, 2003, p. 130; James H. Stock and Mark W. Watson, *Introduction to*
28 *Econometrics*, Addison Wesley: Boston, 2003, pp. 468–469; and Jeffrey M. Wooldridge, *Introductory*
Econometrics: A Modern Approach (3rd ed.), Thomson South-Western: Mason, OH, 2006, pp. 249–252, 454.

¹⁰ As I have discussed above, I am not opining that conspiracies cannot result in uneven impact. I am instead stating
that the use of a common measure for disparate effects violates the necessary predicate assumptions for using the
model Dr. Liu has chosen. If the alleged conspiracy waxed and waned in substantive ways, a common measure of
its effect is unquestionably inappropriate as a matter of economics and statistics.

1 there is a clear rejection of a constant price elevation across product types. Estimates of the
2 percentage price changes vary even more than for the Transaction data. See Appendix A.

3 16. Therefore, the statistical evidence clearly indicates that the class period
4 coefficient is not constant across product types as Dr. Liu's methodology requires. This is a
5 powerful result; it renders his model unreliable, and it follows directly from this conclusion that
6 his estimate of damages is meaningless. One might be tempted to interpret his estimate as an
7 average of the individual product effects and useable as such, but this would be incorrect and not
8 standard econometric practice. Given the extremely wide variation in price effects over the
9 relevant time period (with many products declining in price compared with Dr. Liu's "but-for"
10 price) and many others with a price effect that could not be statistically distinguished from zero,
11 any weighted average masks so much information and such widely disparate economic effects
12 that it is meaningless as a matter of economics. Clearly, any 'averaged' influence does not
13 describe the market conditions faced by the individual products. Furthermore, it is incorrect and
14 non-standard econometric practice to 'average' across variables that have demonstrably (in a
15 statistical sense) different means. Consequently, the fact that Dr. Liu's coefficient is a weighted
16 average is merely an artifact of the statistical procedure, but does not assist in capturing the
17 actual economic factors that influence the price of the individual products.

18 17. Moreover, it would be necessary first to study the individual price effects
19 and show that they have a sensible interpretation. The observed variation in the individual price
20 effects is so wide that it provides evidence that the model is measuring something besides
21 possible systematic price elevation.¹¹ If, for example, close product substitutes do not have
22 similar price effects the hypothesis of collusive pricing would be clearly refuted – some other
23 factor, uncaptured by the model, is a likely driver of the observed differences.

24 18. The failure to pass the basic test of a constant "price elevation" for all
25 product types means that Dr. Liu's method does not estimate damages. The "class period"
26 variable coefficient has no economic meaning and is unreliable for measuring damages (or
27

28 ¹¹ This is one of the perils of measuring damages as a residual. See below for a further explanation, as well as my
Expert Report, pages 19-22.

1 impact) in this case.

2 19. The same theoretical issue applies to possible differences across
3 manufacturers and time. The econometric underpinnings of Dr. Liu's analysis require the price
4 change within a given class period to be the same for all manufacturers throughout the entire
5 time period. I discuss my test across time periods, and then by manufacturer in the sections that
6 follow.

7 **IV. SECOND IMPLEMENTATION OF THE STANDARD TEST: TEMPORAL**
8 **POOLING**

9 20. As noted above, Dr. Liu's econometric method measures an alleged
10 elevation of prices caused by the assumed conspiracy through residuals, differences in observed
11 prices and predicted prices over a time period. The predicted prices in this price difference
12 depend on a set of variables that must explain what prices would have been in the absence of a
13 conspiracy that successfully raised prices. Whether Dr. Liu's prediction variables succeed in
14 explaining prices outside the class period is also testable using the standard test for parameter
15 stability described above: one can test whether the pricing parameters that are not related to the
16 "conspiracy variable" are stable over time. If not, this is clear evidence that Dr. Liu's model
17 cannot explain prices well, even outside the period of alleged conspiracy, making the baseline
18 useless for comparison purposes.

19 21. A simple and direct version of this test is to compare the coefficients for
20 predicting non-conspiratorial prices for the periods before and after the alleged conspiracy. Dr.
21 Liu has described a version of this test in his chapter on damages: "If the model were reliable and
22 there was impact from collusion, then ... the model, if estimated during a sub-period of the non-
23 collusive period, should be able to accurately predict prices in the rest of the non-collusive
24 period."¹² In essence, what Dr. Liu's model does is take actual prices during the class period,
25 which are assumed to be conspiratorial, and then estimate what prices would have been absent
26 the assumed conspiracy based on observing the behavior of prices outside the class period. It

27 ¹² See ABA Handbook, "Econometrics: Legal, Practical, and Technical Issues," Chapter VII (Damages), pp. 175-
28 177. This quotation is on page 175. I performed similar versions of this test in my Expert Report of October 2,
2006.

1 follows that Dr. Liu's model for non-conspiratorial prices must be able to predict non-
2 conspiratorial prices after the class period using the non-conspiratorial prices observed before
3 that period (or vice versa). If the observable non-conspiratorial prices are not predicted correctly
4 then there is evidence that the non-observable non-conspiratorial prices (i.e., the hypothetical
5 prices proposed by Dr. Liu during the class period) are not predicted correctly either. In part, the
6 standard test examines whether Dr. Liu's model correctly predicts a period of observable non-
7 conspiratorial prices.

8 22. My staff and I carried out the appropriate statistical test under the
9 assumptions contained in Dr. Liu's report and using the programs Dr. Liu provided for his
10 calculations. The results of this test appear in Appendix C. This test clearly rejects the
11 assumption. Dr. Liu's model fails to predict non-conspiratorial prices.

12 23. In his rebuttal report, Dr. Liu rejected my original tests of this temporal
13 pooling problem, on the basis of vague statistical grounds and ungrounded insinuations about
14 "snooping."¹³ Despite his claims, a generally accepted standard econometric test for this form of
15 temporal pooling is to include the "pre" variable in the regression and calculate whether its
16 estimated coefficient is statistically significantly different from zero. This is the test that I have
17 applied in the past to his original model and apply now, here, which rejects the conclusion that
18 Dr. Liu's models can predict non-conspiratorial (or as a result, the alleged conspiratorial) prices.
19 See Appendix D.¹⁴ What Dr. Liu offers in his rebuttal report as the correct test is not standard
20 and he gives no references to support his unusual test method.

21 24. Without the ability to predict non-conspiratorial prices, Dr. Liu's method
22 cannot estimate a difference between conspiratorial and non-conspiratorial prices. This renders
23 the estimate of damages derived by Dr. Liu from his model, unreliable as a matter of economics
24 and statistics.

25
26 ¹³ Rebuttal Report of Paul C. Liu, pp. 20-21.

27 ¹⁴ In my Expert Report, using Dr. Liu's original model and original baseline period prior to the Class Period, this test
28 demonstrated statistically significant and *positive* "price elevation" in the "pre" period unexplained by other
variables in Dr. Liu's model. Running this test on Dr. Liu's current model and current baseline period prior to the
Class Period results in a statistically significant and *negative* coefficient for that same period. This inconstancy is
further evidence of the instability and unreliability of Dr. Liu's model.

1 25. I also examined the stability of parameters **within** the class period across
2 time. Because it is my understanding that Nanya is alleged to have joined the conspiracy on or
3 around August 1, 2001, it is germane to ask whether the class period price effect is the same in
4 this period as it was prior to the period in which Nanya is alleged to have participated. As
5 explained above, a clear failure to pass the test for parameter stability invalidates the pooling of
6 the measure of "price elevation" into a single estimate covering the entire class period, and
7 renders Dr. Liu's damage estimate unreliable.

8 26. My staff and I carried out the appropriate statistical tests for this temporal
9 split under the assumptions contained in Dr. Liu's report and using the programs Dr. Liu
10 provided for his calculations. The results of this test appear in Appendix E. Dr. Liu's model
11 fails this parameter stability test as well. A graphical representation of this split appears in
12 Exhibit C.

13 **V. THIRD IMPLEMENTATION OF THE STANDARD TEST: MANUFACTURER**
14 **POOLING**

15 27. I also examined the stability of parameters within distinct time subperiods
16 across manufacturers.¹⁵ It is similarly germane to ask whether the class period price effect is the
17 same for individual firms (such as Nanya or Mosel) as for other manufacturers in each of these
18 two periods suggested by Plaintiffs' allegation that Nanya joined the alleged conspiracy on or
19 around August 1, 2001. It is also appropriate to test the stability of the model's parameters
20 across time and manufacturer for the three-way split suggested by the Plaintiffs' allegation of an
21 eight-month cessation of "price elevation" collusion between April and November 2001. Within
22 each of these alleged sub-periods, individual firm behavior should be appropriately similar to
23 justify the pooling. Again, a clear failure to pass the test for parameter stability invalidates Dr.
24 Liu's damage estimate.

25 28. My staff and I carried out the appropriate statistical tests under the
26 assumptions contained in Dr. Liu's report and using the programs Dr. Liu provided for his

27 ¹⁵ Note that in the case of manufacturers, not only is Dr. Liu pooling his estimate of "price elevation," he has pre-
28 aggregated the data for all manufacturers together. Thus to perform this test I had to first re-disaggregate each
company's transaction data back to the disaggregated format which Dr. Liu received from Defendants.

1 calculations. The results of this test appear in Appendix F. This test clearly rejects the
2 assumption. Dr. Liu's model fails this parameter stability test as well.

3 29. The estimated price effects are worthy of note because they also illustrate
4 the fragility of Dr. Liu's models. As Exhibit D shows, the estimate of the price effect for Nanya
5 before it is alleged to have joined the conspiracy as a 100% "elevation" of its price. Conversely,
6 during the time that Nanya was alleged to have participated in the conspiracy, its price appears to
7 have been "depressed" by almost 50%. Such nonsensical results are symptoms of an unreliable
8 model.

9 **VI. FOURTH IMPLEMENTATION OF THE STANDARD TEST: CUSTOMER**
10 **POOLING**

11 30. A similar issue exists with respect to the question of whether Dr. Liu's
12 model appropriately pools customers. While one can think of each customer as distinct, it
13 certainly is the case that in this industry three broad types of customers, Tier 1, Tier 2, and Spot,
14 have been identified.¹⁶ One could ask if pooling across these three customer types to estimate a
15 common "price elevation effect" is appropriate. My understanding is that this question is
16 particularly apt because many (and perhaps most) of the Tier 1 customers have opted out of the
17 class.

18 31. For this test, I have used Dr. Liu's DeDios models even though they do
19 not report individual company prices and are thus deficient for manufacturer-level analysis.
20 However, for the purpose of investigating the customer pooling issue, they do provide some
21 information about customer types, which enables this particular illustrative inquiry.

22 32. Dr. Liu's De Dios data contains a flag as to whether prices pertain to Tier
23 1, Tier 2, or spot customers. By interacting these flags with the "class period" variable, I am able
24 to test whether each type of customer's "price elevation" was sufficiently common to pool. The
25 results of this test appear in Appendix G and are graphically depicted in Exhibit E. This test
26 clearly rejects the assumption and thus Dr. Liu's model fails this parameter stability test as well.
27 In essence, this break-out shows that spot customers, Tier 2 customers, and Tier 1 customers are

28 ¹⁶ See for example, the Expert Report of Paul C. Liu, pp. 8-9.

1 not sufficiently similar in the estimate of “pricing elevation” to be lumped together for the
2 purposes of calculating damages, and when estimated individually, spot customers showed no
3 significant “price elevation” during the class period, nor did Tier 2 customers for certain version
4 of Dr. Liu’s models.¹⁷

5 VII. OTHER IMPLICATIONS OF POOLING

6 33. As a matter of economics, Dr. Liu’s decision to pool non-class members
7 and class members together in his estimation has additional implications. At the most
8 elementary level, simply taking one of his model’s predicted “overcharge” values and
9 multiplying it by all sales (rather than restricting the analysis to class members’ sales) results in
10 an overstatement of damages attributable to the class.¹⁸ But at a more important level, even if
11 Dr. Liu’s model were otherwise economically and statistically acceptable for the task at hand, his
12 failure to confine his measure of the “elevation” during the class period to sales to class
13 members makes his regression work an irrelevant exercise. Testing whether an average of class
14 members and non-class members, together, is higher than some predicted value provides little or
15 no insight into whether that result is driven by the class members, by the non-class members, or
16 by some of each. The results of the pooling test on customers provide some indication that class
17 members and opt-outs experience distinctly different pricing. In the face of this, there is no
18 statistical support for the conclusion that the pooled average of the two distinct sets of customers
19 is a good proxy for the prices faced by class members alone.

20 34. This highlights one of the basic economic truths of averaging. When one
21 creates an average, by pooling econometrically or through other means, one is making an

22
23 ¹⁷ I also tested the alternate hypothesis that Spot and Tier 2 customers, after segregating out Tier 1, showed sufficient
24 common “price elevation” to allow a pooled result. In one of Dr. Liu’s two weightings, this hypothesis was ruled
25 out. In the other it was not.

26 ¹⁸ I’ve undertaken a high-level review of the opt-outs given to me in the October 10, 2006 Exclusions Report. While
27 matching up customer names to transactions is not a straightforward process, I believe that at the very minimum
28 \$7.8 billion in Dr. Liu’s sales base is to non-class members. Using the 18.5% figure from his Transaction data
model, this corresponds to \$1.2 billion in alleged “overcharges” to customers that are not part of the class. These
numbers are certainly an underestimate of the true number of opt-outs, because data from both Samsung and Critical
do not contain customer identities and thus I could not match names to any of those sales. In fact, I was only able to
even determine a customer name for about 54% of the transactions in Dr. Liu’s data. As a result, the true value for
sales to non-class members incorrectly included by Dr. Liu in his damages estimate is almost certainly substantially
higher. See Appendix H.

1 implicit argument that the average is a good proxy for each individual observation that is pooled.
2 The tests that I have performed demonstrate, for Dr. Liu's models, that this assumption does not
3 hold. But without verifying this critical step, one cannot determine whether the average that was
4 derived has much (or any) relationship to whether **all** observations behaved similarly. If the
5 question of interest is whether each customer's prices (or each manufacturer's or each product's
6 or each time period's prices) increased during the class period, it is certain that Dr. Liu's pooled
7 model does not provide a meaningful answer. In fact, the failure of Dr. Liu's models to pass the
8 standard econometric tests for pooling along each of these dimensions suggests that, in fact,
9 some customers (and some manufacturers, products, and time periods) did **not** experience any
10 elevation at all.

11 **VIII. AN ERROR IN THE INDEPENDENT VARIABLE "WEB SERVER STARTS"**

12 35. Separate from Dr. Liu's inappropriate pooling of data, there is a critical
13 mistake in one of the variables that Dr. Liu uses to predict prices outside the alleged periods of
14 collusion. Because price prediction outside the class period must be credible for Dr. Liu's
15 method of determining "but-for" prices to be reliable, this mistake also renders his class period
16 conclusions unreliable.

17 36. The mistake involves one of Dr. Liu's measures of demand, the number of
18 web server starts in each month. To measure this, Dr. Liu subtracts the number of servers in the
19 previous month from the number of servers reported in current month (less an allowance for
20 server replacements). Dr. Liu then uses the natural logarithm of this variable as an explanatory
21 variable to help predict non-collusive prices in his regressions.

22 37. There are two months where the method used by Dr. Liu to estimate web
23 server starts results in a negative number, July and August 2002. As a matter of mathematics,
24 the logarithm of a negative number is undefined. Dr. Liu thus substitutes the value 1 (one) to
25 web server starts for each of these months in which his standard method generates negative
26 starts, thereby assigning 0 (because the natural log of one is zero) to the corresponding
27 explanatory variable in his regression. This is an arbitrary and erroneous substitution and the
28 substituted values stand out clearly as outliers. (See Exhibit F.) There is no theoretical

justification for this substitution, nor is it standard practice.

38. Moreover, this mistake has a substantial impact on the estimates that Dr. Liu's programs compute. The simplest correction is to drop from the analysis observations in these two months.¹⁹ Dr. Liu's damage coefficient changes from 0.17 to 0.13, and more importantly, the resulting coefficient is not statistically significantly different from zero.²⁰ While on its own, this change in coefficient would translate into a \$602 million change in Dr. Liu's measure of damages (which would mean his current version contains a 25% overstatement), it more importantly speaks to the need for an adequate model for predicting prices outside all periods of conspiracy – without an appropriate baseline, conclusions about “price elevation” cannot be relied upon.²¹

39. Moreover, the very fact that Dr. Liu's measure of demand for DRAM can result in negative web server sales highlights the flaws of his proxy for server-driven demand. It is beyond credibility that worldwide web server starts are ever near the value 1 in a given month, let alone negative, and the fact that the data series method utilized yields such outcomes draws the entire series and the method, not just two observations, into question.

40. In fact, it is my understanding that the survey on which Dr. Liu relies is a measure of active domain names.²² Since a single server can host multiple domain names and a single domain name can require many servers (think of www.google.com as one example), this survey is, at best, an imperfect measure of new server starts. In the two critical months, July and August 2002, the result that Dr. Liu derives is clearly implausible. However, the fact that in the

¹⁹ Dr. Liu discusses this sort of robustness test in his chapter on damages at pages 169-172, where he describes how the removal of an outlier can invalidate the conclusion of an expert.

²⁰ This is based on Dr. Liu's model of Transaction data, with cumulative output as the “learn-by-doing” variable. I selected this version among Dr. Liu's various transaction models as my base case for testing throughout.

²¹ For a discussion of what economists refer to as the “errors in explanatory variables” problem, see James H. Stock and Mark W. Watson, *Introduction to Econometrics*, Addison Wesley: Boston, 2003, pp. 248–250; Russell Davidson and James G. MacKinnon, *Estimation and Inference in Econometrics*, Oxford University Press: Oxford, 1993, pp. 210–211; Paul A. Ruud, *An Introduction to Classical Econometric Theory*, Oxford Univ. Press: New York, 2000, pp 491–492, 495–497, 502; and Jeffrey M. Wooldridge, *Introductory Econometrics: A Modern Approach* (3rd ed.), Thomson South-Western: Mason, OH, 2006, p. 510.

²² According to the Netcraft survey for December 2002 (at <http://survey.netcraft.com/index-200212.html>, last visited February 14, 2007): “The Netcraft Web Server Survey is a survey of Web Server software usage on Internet connected computers. We collect and collate as many hostnames providing an http service as we can find, and systematically poll each one with an HTTP request for the server name. In the December 2002 survey we received responses from 35,543,105 sites.”

1 other months the number is not implausible does not suggest that the number he derives is at all
2 accurate.

3 **IX. STATISTICAL SIGNIFICANCE IS NOT THE SAME AS IMPACT, AS**
4 **ECONOMISTS USE THE TERMS**

5 41. I've reviewed the January 17, 2007, deposition of Dr. Liu, where he
6 defined "impact" as he uses it in his work to mean: "... a determination of whether a, any price
7 elevation that I might be finding, whether that price elevation is statistically significant."²³

8 42. Statistical significance is a term of art in statistics and econometrics. In
9 the context of Dr. Liu's models, statistical significance means that the probability that the
10 particular measured effect (in this case, his estimated class period coefficient) is actually zero is
11 less than 5 percent. Put simply, statistical significance tells you that the probability that the
12 measured effect is purely random is unlikely. However, by no means does statistical significance
13 provide any answers to **what** the explanation of the measured effect is, and thus to infer any
14 concept of conspiratorial impact from a finding of statistical significance alone is well outside
15 the standards of the discipline of econometrics.^{24,25}

16 43. In particular, therefore, I find no economic or econometric validity to Dr.
17 Liu's claim (in his original report) that "I do not assume for purposes of my report that the
18 conspiracy was effective in raising prices above the prices that would have pertained absent the
19 conspiracy ... Instead, my conclusions are based on my analysis of the pricing data."²⁶ As he
20 has testified, his model has the potential to demonstrate consistency (or inconsistency) with the

21 ²³ Deposition of Paul C. Liu, January 17, 2006, p. 309:18 -310:1

22 ²⁴ Most basic statistics text book are quick to explain that statistical significance is not to be confused with actual
23 significance. For example, "Since 'significant' is often used interchangeably with 'meaningful' or 'important' in
24 everyday language, it must be understood that we are using it here as a technical term. If a result is statistically
25 significant, this does not mean that is necessarily of any great importance or that it is of any practical value." John
26 E. Freund, *Modern Elementary Statistics*, Prentice-Hall: Englewood Cliffs, NJ, 1988, p. 298. See also
27 Arthur S. Goldberger, *A Course in Econometrics*, Harvard Univ. Press: Cambridge, MA, 1991, p. 215.
28 Paul A. Ruud, *An Introduction to Classical Econometric Theory*, Oxford Univ. Press: New York, 2000, p. 231.

²⁵ Similarly, in econometrics one often encounters confusion between "goodness of fit" as measured by R^2 and a
meaningful model. One can easily imagine a model which explains the height of school children solely on the basis
of their grade in school, and that model might have a fairly high R^2 . However, it's clear that grade in school doesn't
cause children to grow taller, and also misses a good deal of the intra-grade variation. The problem would be
further compounded if one only regressed on the average height for each grade. See Arthur S. Goldberger, *A*
Course in Econometrics, Harvard Univ. Press: Cambridge, MA, 1991, p. 177-178.

²⁶ Expert Report of Paul C. Liu, August 28, 2006, p.3.

1 allegation²⁷ or that say whether there is statistical significance. As a matter of economics and
 2 statistics, however, Dr. Liu cannot conclude, based on his analysis, that “the conspiracy was
 3 effective in raising prices above the prices that would have pertained absent the conspiracy.” If
 4 Dr. Liu does not make that assumption (which he says he does not), he certainly cannot reach
 5 that conclusion on the basis of his econometric studies.

6 44. Moreover, the general conclusions about statistical significance assume a
 7 well-specified and reliable model. The finding of statistical significance in an unreliable model,
 8 where the coefficients themselves lack reliability, does nothing to shore up the model’s
 9 credentials. In the case of Dr. Liu’s models, the findings discussed above, which render
 10 unreliable the entire model, also make the statistical findings of significance themselves
 11 meaningless; they are statements about mathematical formulas which cannot speak to the
 12 underlying economic reality due to serious modeling errors.

13 **X. THE MEASUREMENT OF DAMAGES AS A RESIDUAL MEANS**
 14 **ALTERNATIVE HYPOTHESES CANNOT BE TESTED OR RULED OUT.**

15 45. As discussed above, the method used by Dr. Liu cannot provide direct
 16 evidence that an alleged conspiracy actually *caused* prices to be abnormally high. The
 17 econometric method on which he relies is simply an interpretation of correlations. In his rebuttal
 18 report, and his deposition, Dr. Liu has acknowledged this point.²⁸

19 46. As a result, to the extent that untested non-conspiratorial explanations
 20 exist for any observed price changes during the class period (e.g., due to customer-to-
 21 manufacturer communications), Dr. Liu’s model has no means of testing whether some or all of
 22 the effect is driven by the legal or the alleged illegal communications.²⁹ Similarly, to the extent
 23 that one or more manufacturers chose to increase the quality and reliability of their products,
 24 such that on average all else equal, it charged more for products during the class period than the
 25 average of its pre- and post- price, some or all of this increase could be captured by the “class

26 ²⁷ Deposition of Paul C. Liu, January 17, 2007, pp. 310:25 -311:4

27 ²⁸ See Rebuttal Report of Paul C. Liu, pp. 19 and Deposition of Paul C. Liu, pp. 270:5 – 271:23.

28 ²⁹ As another example, a company that was not part of an alleged conspiracy but merely priced competitively relative to other firms, Dr. Liu’s model would show a “price elevation” and by his theory, this would equate to damages. Such a conclusion would clearly be misleading.

1 period" variable, and then mistakenly attributed to damages by Dr. Liu's methodology.

2 47. The misspecification of the web server starts variable, as discussed above,
3 is a concrete example of a situation where the simple failure to measure one independent variable
4 correctly, for only two months, results in what appears to be an 25% over-statement of the
5 alleged damages in this matter, and which gives the "class period" variable an illusory statistical
6 significance. Moreover it nullifies the economic validity of the "class period" variable. Each
7 error, each omission, each misspecification finds its way into the "class period" variable because
8 that variable is the catch-all for all otherwise unexplained variation. By itself, if done right, the
9 use of a residual measure does not invalidate a model. I am not saying the use of a residual is
10 never appropriate. However, given the gross misspecifications in Dr. Liu's work, and the clear
11 possibility of lawful causes for which his model takes no account, by no means does Dr. Liu's
12 "class period" variable provides a reliable measure of damages.

13 XI. CONCLUSION

14 48. For the reasons stated above, I find that Dr. Liu has presented a model
15 which does not meet the econometric standards required for validity and reliability. I do not
16 believe it possesses sufficient econometric rigor to qualify as a well-grounded scientific analysis
17 of pricing in this industry. Furthermore, Dr. Liu misrepresents the relevance of his work to the
18 question of whether the alleged conspiracy was "effective in raising prices" above the prices that
19 would have pertained absent the conspiracy impact, which is a conclusion that cannot be reached
20 on the basis of his econometric studies in this matter.

21 I declare under penalty of perjury under the laws of the United States of America
22 that the foregoing is true and correct.

23 Executed this 15th day of February, 2007, at Greenbrae
24 California.

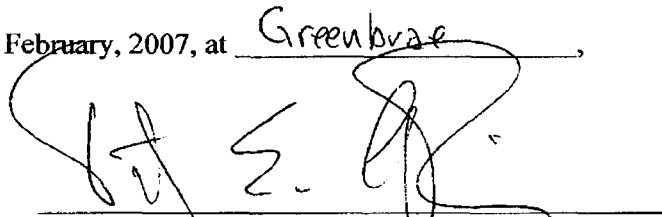
25 
26 Vincent E. O'Brien
27
28

EXHIBIT A

EXHIBIT A

VITA

VINCENT E. O'BRIEN

POSITION: President, The Marin Economic Research Institute, Inc.

AFFILIATION: Director, LECG, LLC

EDUCATION: Harvard Graduate School of Business Administration, Doctor of Business Administration (1973). Studies focused on the impact of economic, demographic, and cultural trends on the financial performance of industries and companies. 1970 - 1973.

Harvard Graduate School of Business Administration. Master in Business Administration (1969).

University of Illinois B.S. (1967) in Electrical Engineering with High Honors. Elected "Outstanding Senior in Electrical Engineering" in 1967. Elected to Tau Beta Pi, Phi Kappa Phi, Eta Kappa Nu, Sigma Tau, and James Scholar Honoraries. 1962 - 1967.

PROFESSIONAL AFFILIATIONS: American Economic Association
National Association of Business Economists
Financial Management Association

OTHER AFFILIATIONS: Member of President's Council, University of Illinois
Director, Marin County Bicycle Coalition
Director, California Bicycle Coalition

PROFESSIONAL AND BUSINESS HISTORY: Putnam, Hayes & Bartlett, Inc., Managing Director 1983 - 1991.
Dickenson, O'Brien & Associates, Inc., Director, 1978 - 1983.
Economic and financial consulting as related to corporate strategy, industry regulation, antitrust enforcement and commercial litigation.

Cambridge Research Institute, Management Consultant. General business consulting, including financial strategy, industry analysis, corporate planning and litigation support. August 1977 – June 1978.

Bethlehem Steel Corporation, Corporate Economist, Planning Department. Had responsibility for economic analysis and forecasting for the U.S. economy and the domestic steel industry. October 1973 – August 1977.

Management Consultant. Provided analytical and computer modeling skills to several public and private clients. September 1970 – October 1973.

Harvard Business School, Research Associate. Case writing and teaching. September 1970 – August 1972.

McDonnell Douglas Astronautics Company, Market Analyst. Huntington Beach, California. Performed business analysis in space and civil systems markets. January 1969 – July 1970.

Vince O'Brien Testimony Since October 1, 2002

Breach of Contract

Circuit Semantics Inc. v. Silvaco Data Systems, Inc. and Ivan Pesic: Before the American Arbitration Association, 74Y1170107103TNC; retained by counsel for claimant, re: valuation in the Information Services: Software Publishing industry (EDA Tools (Circuit Simulation Software)). Testified 8/23/2004 and 8/24/2004.

National Group for Communications and Computers, Ltd. v. Lucent Technologies International, Inc., CV-00-86 (JLL); retained by counsel for defendant, re: lost profit damages in the Manufacturing: Communications Equipment industry (Cellular Systems). Deposed 12/5/2003. Testified 12/15/2003.

Compaq Computer Corporation v. Mag-Tek Inc: Before the United States District Court, Northern District of California, C 02-02158 JW; retained by counsel for plaintiff, re: out-of-pocket damages and lost profit damages in the Manufacturing: Computers & Electronic Products industry (ATM Card Readers). Deposed 1/13/2003.

IP - Breach of License Agreement

Oklahoma Medical Research Foundation v. Eli Lilly and Company: Before the U.S. District Court, Western District of Oklahoma, Case No. CIV-01-456-C; retained by counsel for defendant, re: reasonable royalty in the Manufacturing: Pharmaceutical & Medicine industry (Sepsis Drug: Xigris). Deposed 10/30/2002.

IP - Malpractice

Cambrian Consultants v. Stuart Libtz, Michael Girardi, Hogan & Hartson and Spendly, Horn, Jubis & Lubtiz; retained by counsel for plaintiff, re: reasonable royalty in the Manufacturing: Computer Peripheral Equipment industry (Disk Drives). Deposed 7/16/2003.

IP - Patent Infringement

Ariad Pharmaceuticals, Inc., MIT, The Whitehead Institute for Biomedical Research, Harvard v. Eli Lilly & Co: Before the U.S. District Court, District of Massachusetts, Civil Action No. 02-CV-11280-RWZ; retained by counsel for defendant, re: reasonable royalty in the Manufacturing: Pharmaceuticals & Medicine industry (Xigris and Evista). Deposed 12/16/2005 and 12/19/2005. Testified 4/25/2006.

Eli Lilly & Co. v. Gerald R. Crabtree and Jorge Plutzky and The United States: Before the U.S. District Court, Southern District of Indiana, Indianapolis Division, 1:03:CV-0520 LJM/WTL; retained by counsel for plaintiff, re: reasonable royalty in the Manufacturing: Pharmaceuticals & Medicine industry (Sepsis Drug: Xigris). Deposed 10/7/2005.

ICU Medical, v. B. Braun Medical: Before the U.S. District Court, Northern District of California, CV-01-3202 EDL; retained by counsel for plaintiff, re: lost profit damages and reasonable royalty in the Manufacturing: Surgical and Medical Instruments industry (IV Valves). Deposed 3/11/2005.

Mosaid Technologies, Inc. v. Infineon Technologies North America Corp., Infineon Technologies AG, Infineon Technologies Holding North America Corp., and Infineon Technologies Richmond LP: Before the U.S. District Court, District of New Jersey, Civil Action No. 03-4698; retained by counsel for plaintiff, re: reasonable royalty damages in the Manufacturing: Semiconductors industry (Memory Chips - DRAMs). Deposed 2/8/2005.

Acrymed, Inc. and Medline Industries, Inc. v. Convatec an unincorporated division of E.R. Squibb & Sons and Bristol-Myers Squibb Company: Before the United States District Court of Oregon, Case No. 03-CV-741-AS; retained by counsel for plaintiff, re: lost profit damages, reasonable royalty and unjust enrichment damages in the Manufacturing: Pharmaceutical & Medicine industry (Advanced Wound-Care Products). Deposed 4/28/2004.

Vince O'Brien Testimony Since October 1, 2002

Gracenote, Inc. v. Musicmatch, Inc.: Before the United States District Court Northern District of California Oakland Division, C 02-3162 CW; retained by counsel for plaintiff in the Information Services: Database & Directory Publishers industry (Artist, Song Title & Dynamic Content via Internet). Deposed 3/8/2004.

FCI USA Inc. and FCI America's Technology v. Hon Hai Precision Industry and Foxconn Electronics, Inc.: Before the United States District Court Northern District of California San Francisco Division, C-01-1192 CRB; retained by counsel for defendant, re: reasonable royalty in the Manufacturing: Computers & Electronic Products industry (Chip Connectors). Deposed 10/29/2003. Testified 2/10/2004.

Arctic Cat, Inc. v. Injection Research Specialists, Inc. and Pacer Industries, Inc. and Cross-Complaint: Before the U.S. District Court, Northern District of California, Civil Action No. 01-CV-543 MJD/RLE; retained by counsel for plaintiff, re: unjust enrichment damages, lost profit damages and reasonable royalty in the Manufacturing: Transportation Equipment industry (Snowmobiles). Deposed 1/7/2004.

Tekni-Plex, Inc. v. Tenneco, Inc. and Tenneco Packaging and Consumer Products, Inc.: Before the U.S. District Court, Western District of New York, Civil Action No. 00-CV-6041T; retained by counsel for defendant, re: lost profit damages and reasonable royalty in the Manufacturing: Packaging industry (Styrofoam Meat Trays). Deposed 2/6/2003.

Aldec, Inc. v. Xilinx, Inc.: Before the American Arbitration Association, Case No. 74-117-01000-02-GAP; retained by counsel for defendant, re: lost profit damages and reasonable royalty in the Information Services: Applications Software industry (Software for Programming FPGAs). Deposed 2/12/2003 and 1/14/2003. Testified 2/26/2003 and 2/27/2003.

Cambrian Consultants, Inc. v. Maxtor, Quantum HDD and Western Digital Corporation: Before the United States District Court, Central District of California, Case No. 01-04580R(AJWx); retained by counsel for plaintiff, re: reasonable royalty in the Manufacturing: Computers & Peripherals industry (Disk Drives). Deposed 1/16/2003.

IP - Theft of Trade Secrets

Silvaco Data Systems, Inc. v. Aliaksandr Viacheslavovich Antonau, Nikolay Rubanov, Circuit Semantics Inc. and Related Cross Complaint: Before the Superior Court of the State of California, County of Santa Clara, Case No. CV 790514 (as consolidated with CV 790196); retained by counsel for defendants, re: reasonable royalty and unjust enrichment damages in the Information Services: Software Publishing industry (EDA Tools - Circuit Simulation Software). Deposed 8/2/2003.

IP - Trademark Infringement

Government Employees Insurance Co. v. Google, Inc. and Overture Services, Inc.: Before the U.S. District Court, Eastern District of Virginia, Alexandria Division, Civil Action No. 1:04cv507 LMB/TCB; retained by counsel for defendant, re: lost profit damages and unjust enrichment damages in the Information Services: Internet Search Portals industry (Advertising). Deposed 11/29/2004.

PUBLICATIONS, SPEECHES, SEMINARS & PATENTS

Articles

"Economics and the Key Patent Damages Cases" by Vincent E. O'Brien, in the INTELLECTUAL PROPERTY LAW JOURNAL, University of Baltimore School of Law, Volume 9, Number 1, Fall 2000.

"A Study of Class Action Securities Fraud Cases 1988-1996," by Vincent E. O'Brien, D.B.A.; unpublished, 1996.

"A Study of Class Action Securities Fraud Cases 1988-1993," with Richard W. Hodges; unpublished, 1993.

"A Study of Class Action Securities Fraud Cases," with Richard W. Hodges; unpublished, 1991.

"The Class-Action Shakedown Racket," THE WALL STREET JOURNAL, September 10, 1991; with Richard W. Hodges.

"Economic Damages Under California's Right of Publicity Law," with Lynne Klein; unpublished draft, 1991.

"A Guide to Calculating Lost Profits," THE NATIONAL LAW JOURNAL, January 29, 1990; with Joan Meyer.

Chapters in Books

Roman L. Weil, Michael J. Wagner, and Peter B. Frank, (ed.). "Patent Infringement Damages" in *Litigation Services Handbook: The Role of the Financial Expert*, Third Edition, Chapter 24, John Wiley & Sons, Inc.

Dunn, Robert L. (ed.). "The Calculation of Lost Profit Damages" in *Recovery Of Damages For Lost Profits 5th Edition*, Lawpress Corporation, 1998.

Cases

"Donna Taylor v. Shape-Up Stores," with Betsy Lear and Henry Hecht, 1989.

"A Note on Input-Output Analysis," Harvard Graduate School of Business, 1972.

Various business cases for Harvard Graduate School of Business, 1970-1973.

PUBLICATIONS, SPEECHES, SEMINARS & PATENTS

Continued

Speeches & Seminars

Panel member, *Class Action Suits and Settlements: Information Update* session of the, *Claims and Litigation Management Seminar*, June 19-20, 1995, San Francisco.

Panel member, *The Economics of Patent Damages*, before The 1994 Patent Litigation Institute Conference, October 10-11, 1994, Washington, DC.

Panel member, *Aggressively Responding to Class Action Suits: Evaluating Claims and Damages in 10(b) 5 Fraud Cases*, before The Securities Law Institute for Corporate Counsel, October 25-26, 1993, New York City.

Panel member, *Expenses in International Patent Litigation*, Stanford Law School, Law & Technology Conference, May 1 and 2, 1992.

Panel member, *The Bottom Line on Damages: Soft Proof and Hard Problems*, before the American Bar Association Section of Litigation, Chicago, October 24-26, 1991.

Economic Damages Under California's Right of Publicity Law before the California Judges Association and the Intellectual Property Section of the California Bar Association, Los Angeles, 1991.

The Efficient Market Model: Basic v. Levinson at the Putnam, Hayes & Bartlett, Inc. annual law and economics seminar, Phoenix, 1988.

Seminars Organized

The Efficient Market Model: Where is it Taking Us, 1990.

Polaroid v. Kodak: A New Damages Approach, 1990.

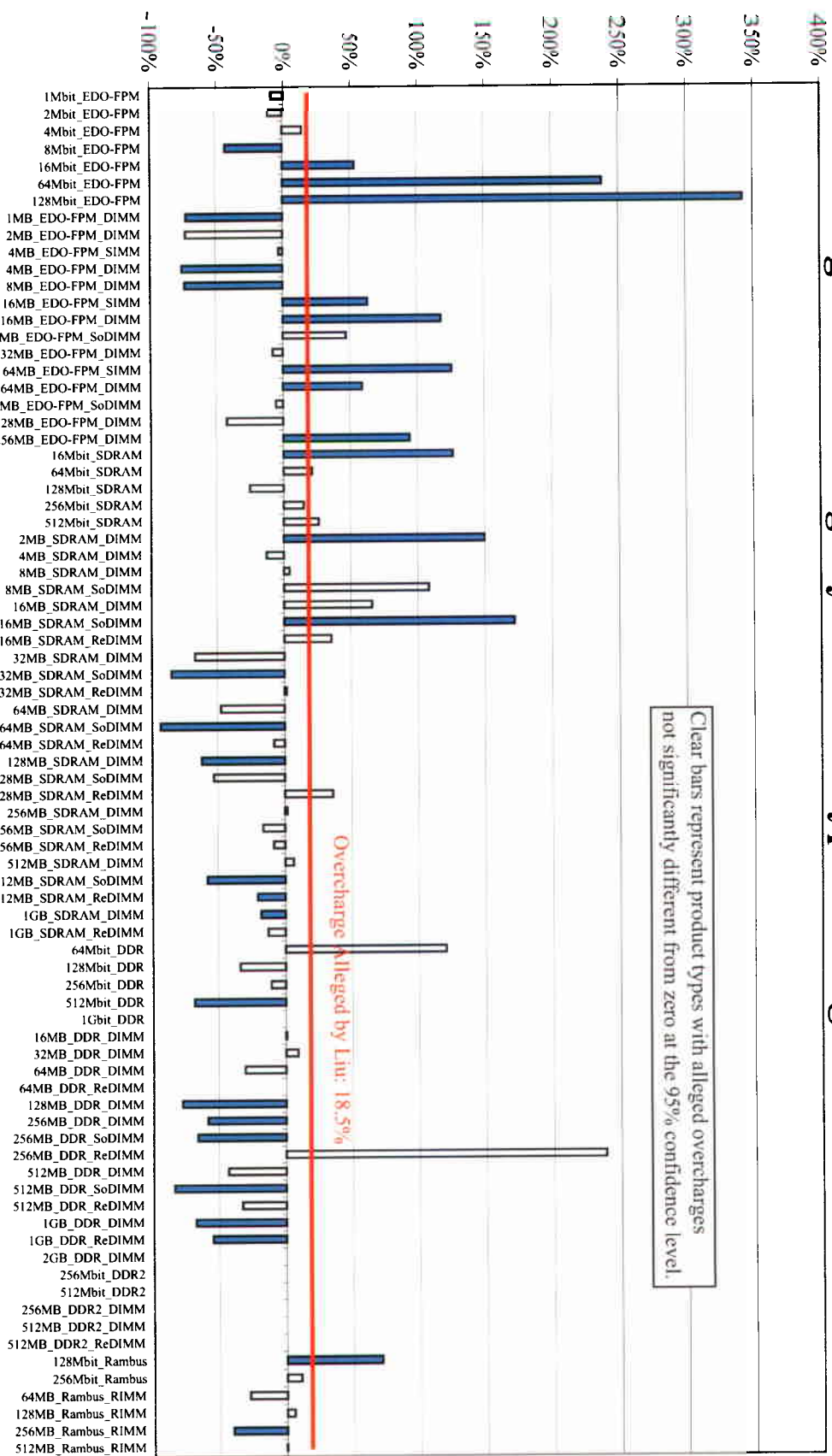
California Insurance Reform and a Reasonable Rate of Return, 1990.

Patents Awarded

United States Patent Numbers 5,695,100 and 5,934,529

EXHIBIT B

Exhibit B: Alleged Overcharge by Product Type During Class Period



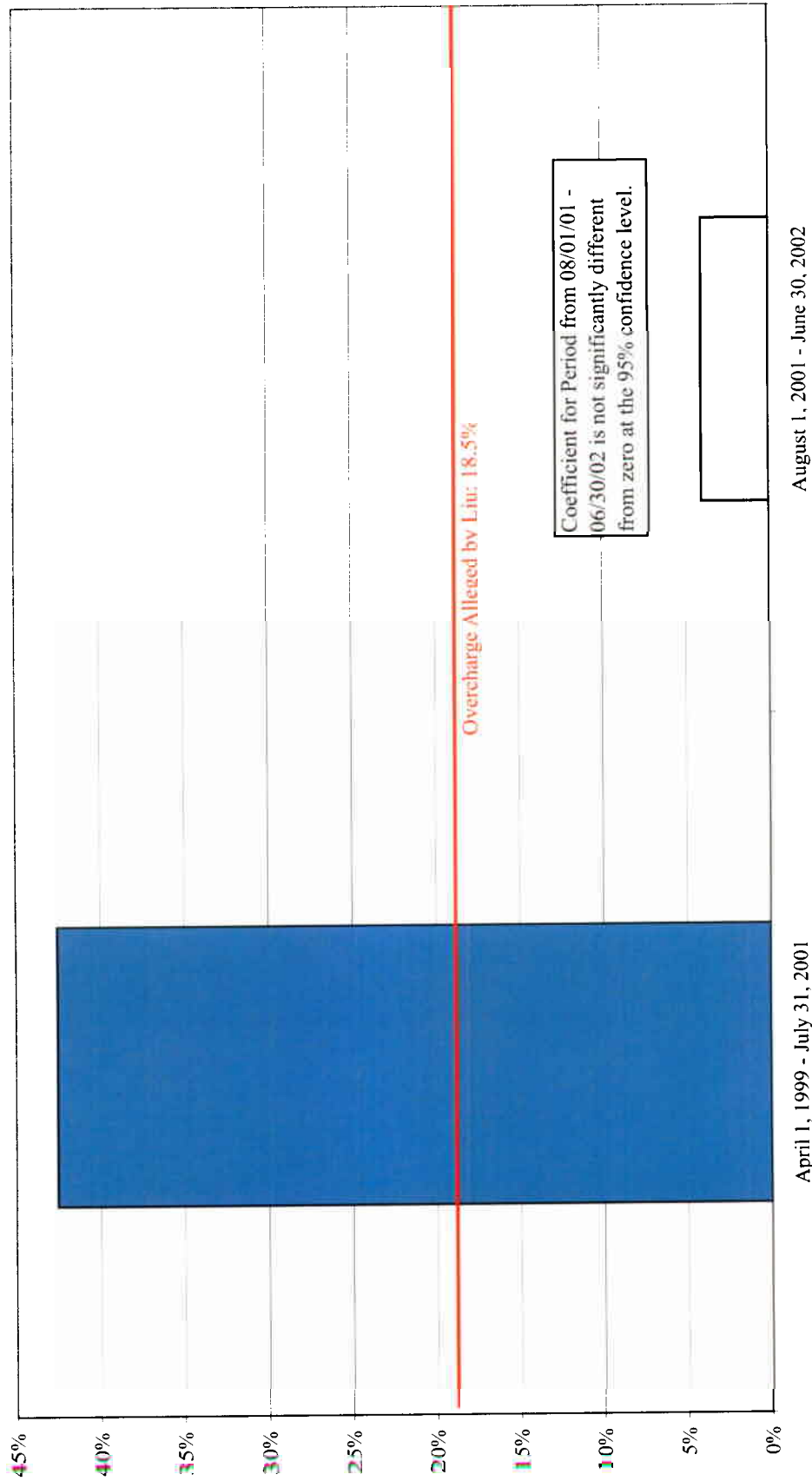
Note: Alleged overcharges are based on a modification of Dr. Liu's transaction data regression where the class period indicator variable (4/1/99-6/30/02) is interacted with the 80 product types represented in his dataset. Percent Overcharge = $e^{\text{coeff}} - 1$.

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EXHIBIT C

Exhibit C

Alleged Overcharges in Two Portions of Class Period



Note: Alleged overcharges are based on a modification of Dr. Liu's transaction data regression where the class period indicator variable (4/1/99-6/30/02) is divided into two subperiods as of August 1, 2001, when Plaintiffs allege that Nanva entered the conspiracy. Percent Overcharge = $e^{\text{coeff}} - 1$.

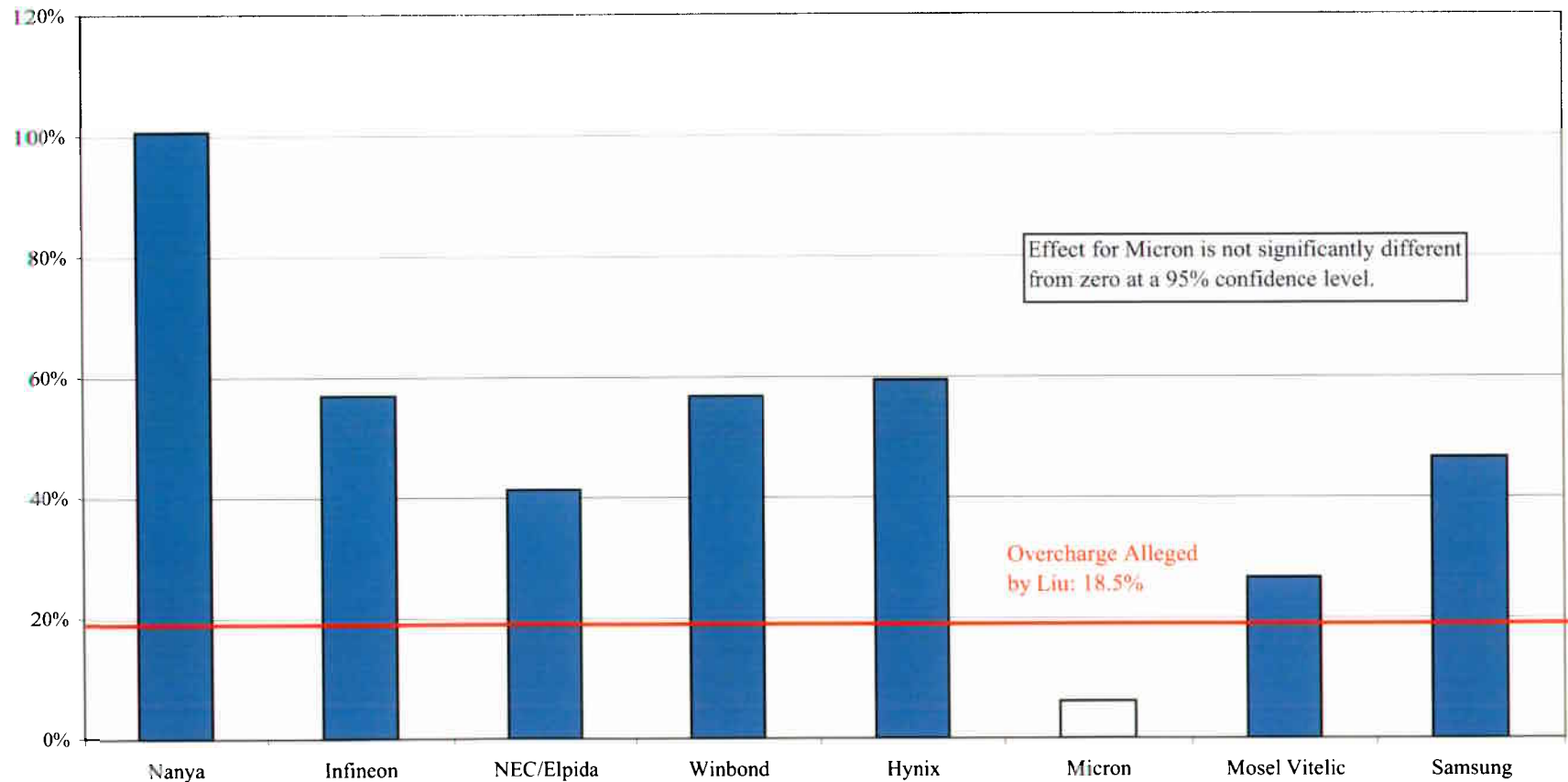
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EXHIBIT D

Exhibit D.1

Alleged Overcharge by Manufacturer

Period 1: April 1, 1999 - July 31, 2001

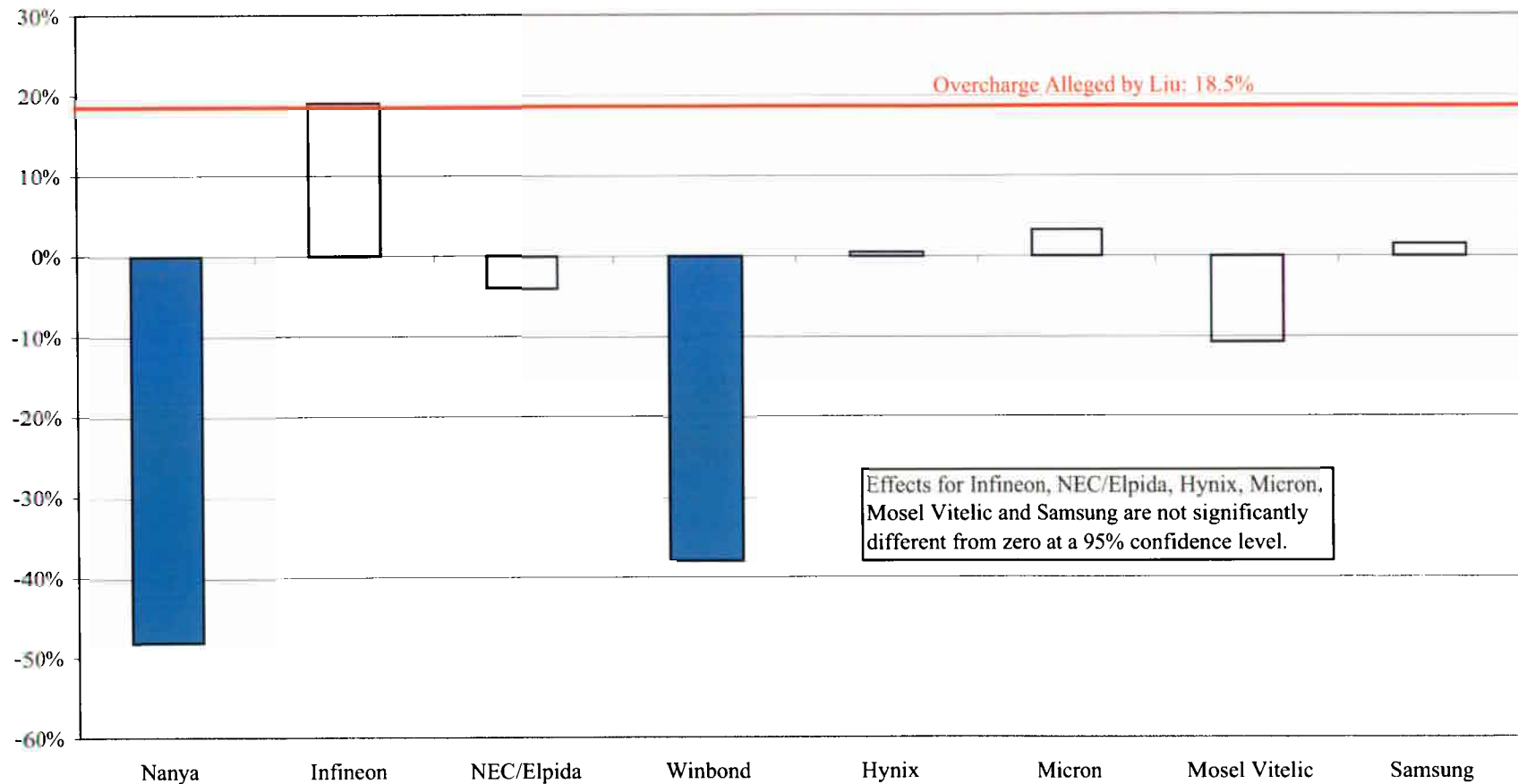


Note: Alleged overcharges are based on a modification of Dr. Liu's transaction data regression where indicator variables for two portions of the class period are interacted with the 8 manufacturers' represented in his dataset. Percent Overcharge = $e^{\text{coeff}} - 1$.

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Exhibit D.2

Alleged Overcharge by Manufacturer Period 2: August 1, 2001 - June 30, 2002



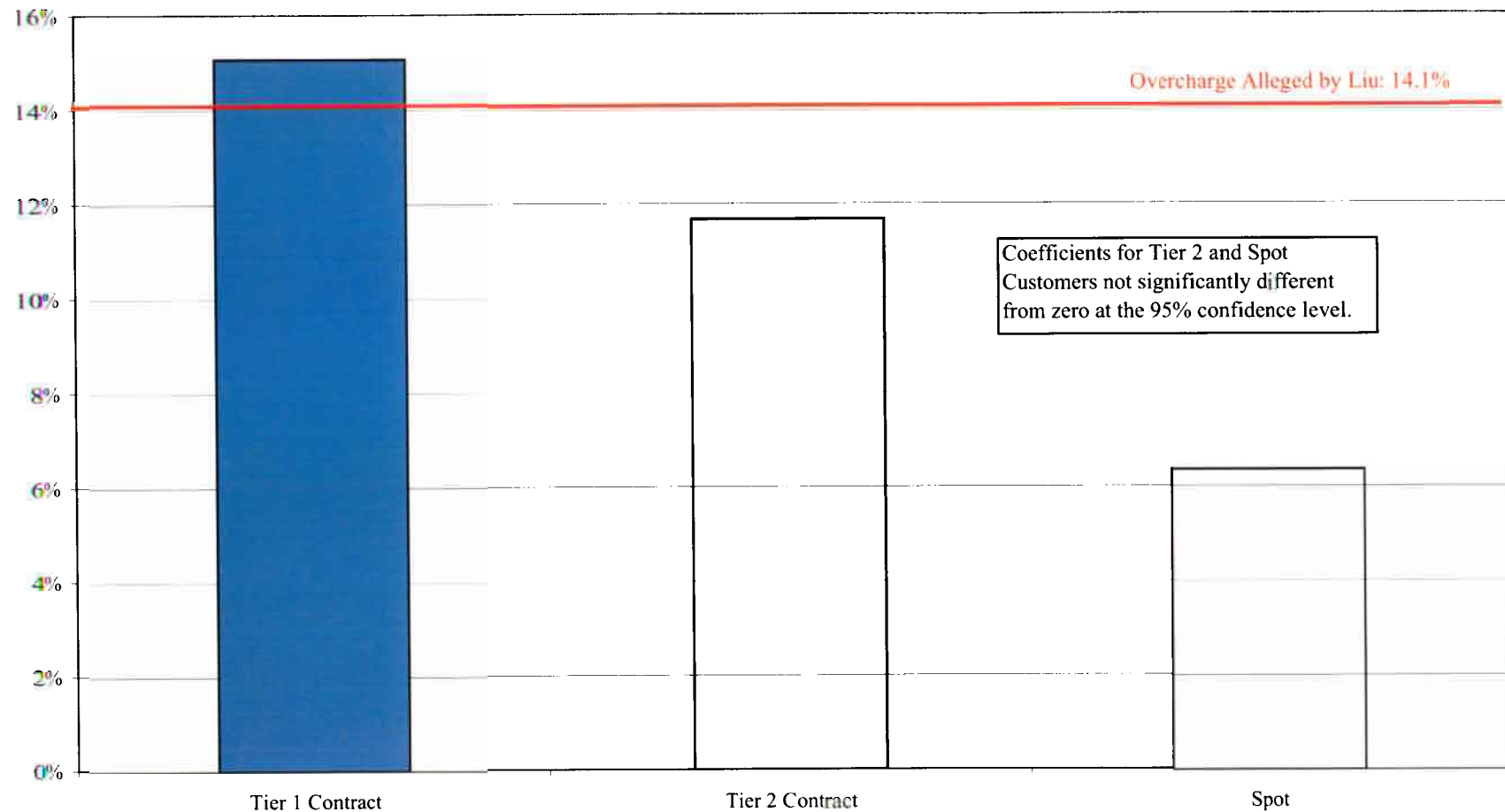
Note: Alleged overcharges are based on a modification of Dr. Liu's transaction data regression where indicator variables for two portions of the class period are interacted with the 8 manufacturers' represented in his dataset. Percent Overcharge = $e^{\text{coeff}} - 1$.

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EXHIBIT E

Exhibit E

Alleged Overcharges by Customer Type in Class Period



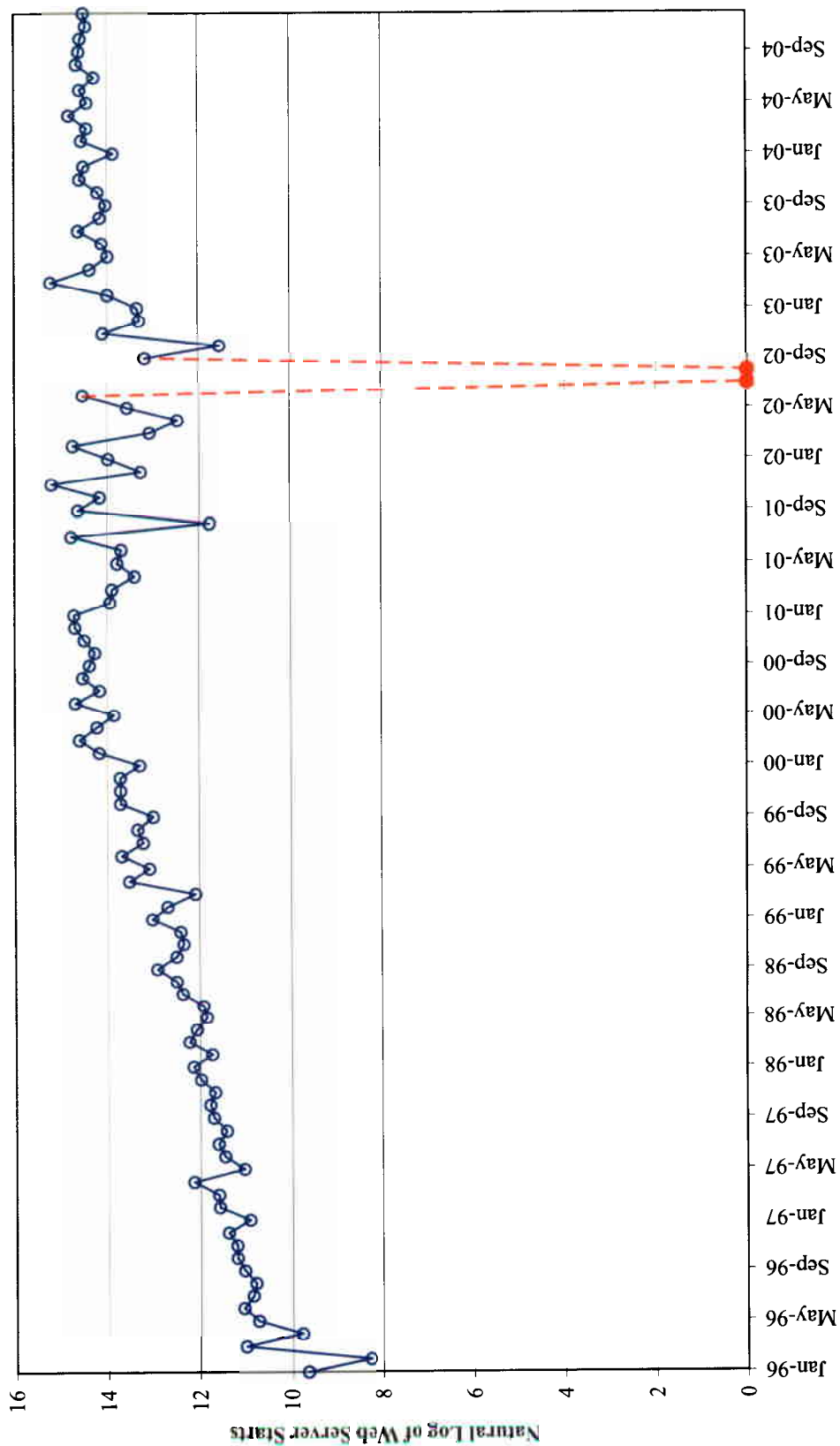
Note: Alleged overcharges are based on a modification of Dr. Liu's DeDios data regression (Hall weighting) where separate indicator variables are assigned to three types of customers. Percent Overcharge = $e^{\text{coeff}} - 1$.

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EXHIBIT F

Exhibit F

Measure of "Web Server Starts" in Liu Regression Model



Sources: "netcraft.csv" and "reg7x.do" as provided in Dr. Liu's rebuttal report.

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